

Accelerator Test Facility

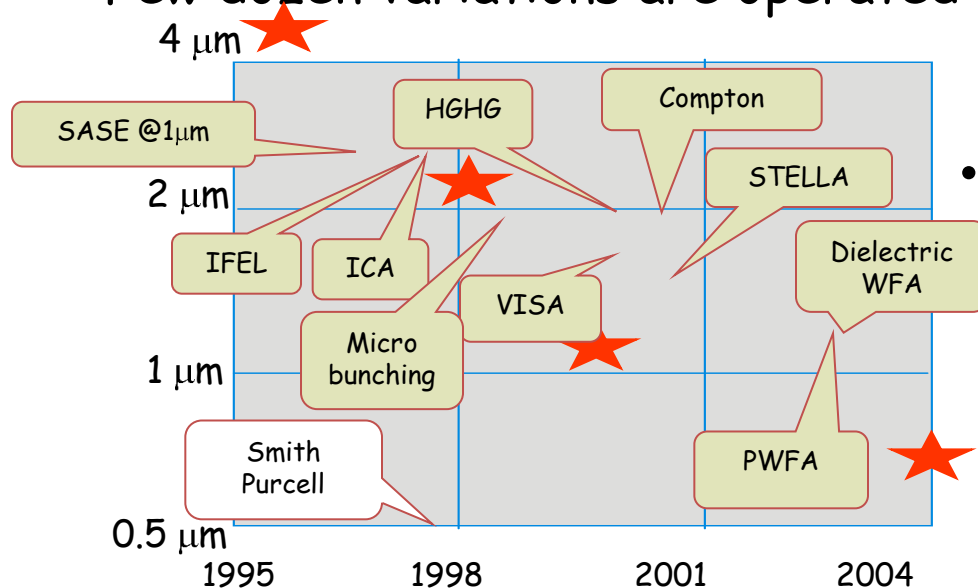
Vitaly Yakimenko
September 8, 2009

Outline:

- Recent past:
 - Multibunch Plasma Wakefield Experiment
 - Imaging of CO₂/plasma interaction with green laser
 - Polarized positron source development for ILC/CLIC, SuperB and LeHC.
 - Fire incident
- Near future
 - CSR studies for eRHIC
 - Beam filamentation instability, plasma holography...
 - Compact X ray source
 - X band installation
 - Short tests (Omega wiggler, Cornell; Detector testing, Phoenix, ...)
- Organization chart

BNL/SLAC/UCLA 1.6 Cell Gun

- Gun was designed, build and tested in diverse collaboration.
- It was tested at User Facility.
- Needs of user experiments pushed reliability and brightness.
- ATF played key role in changing community perception from *"It will never be stable"* to *"let's order one"*.
- Few dozen variations are operated world wide.



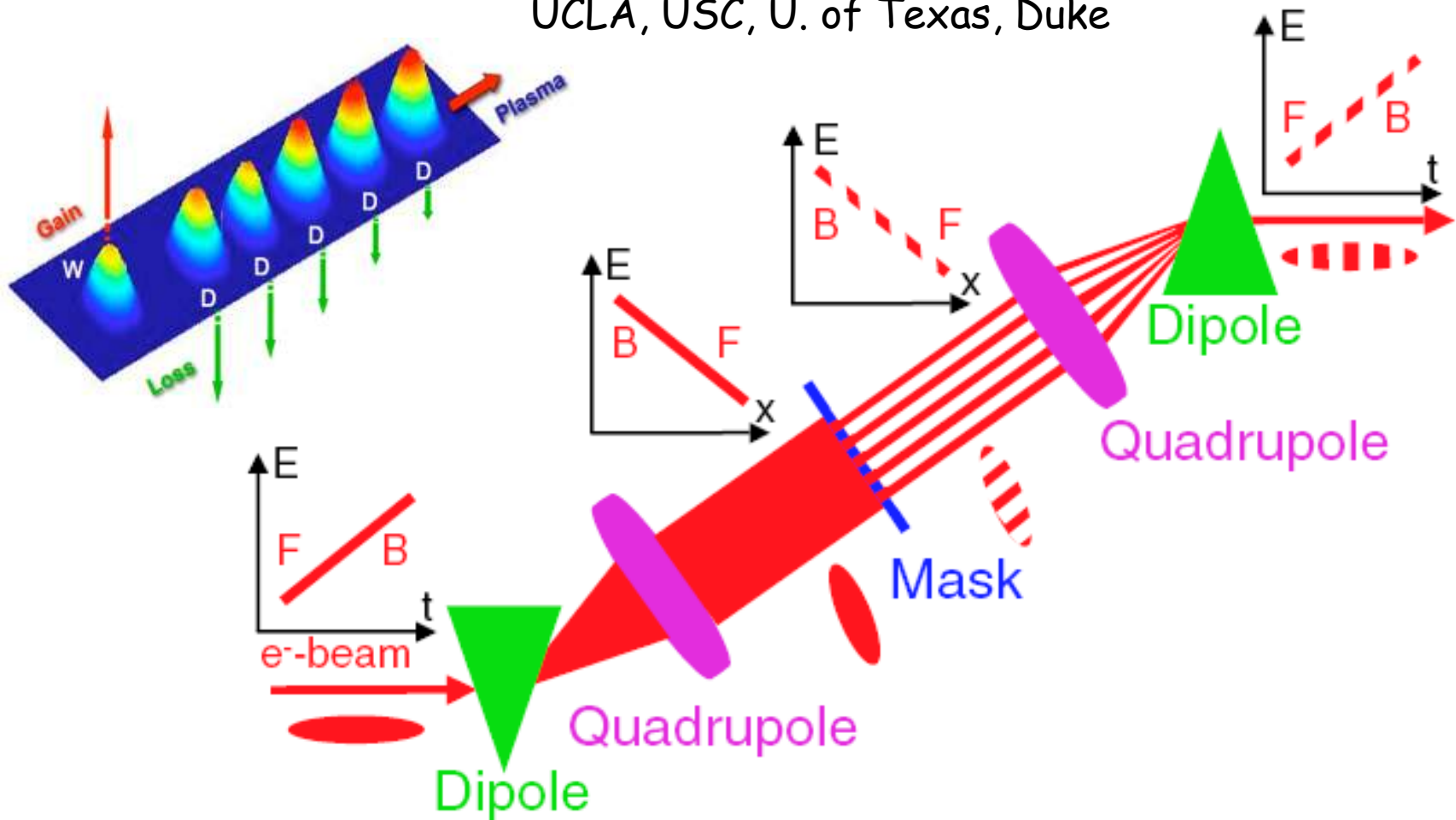
- *Gun is commercially available from multiple sources.*

Vitality of the program

- Only fraction of experimental programs at ATF was discussed in the presentation.
- The universities, small businesses and industries contribute resources and make program very diverse
- Experimentalists from 15 universities visited ATF in the six months before the fire:
 - UCLA, USC, U. of Texas, Duke
 - Columbia, Yale
 - U. of Milan, Pisa, Rome, Sassari
 - SUNY SB, U. Glasgow, Imperial College, Oxford
 - Cornell
- Six SBIR projects from five different companies are using or planning on using ATF resources in a near future

Multibunch Plasma Wakefield

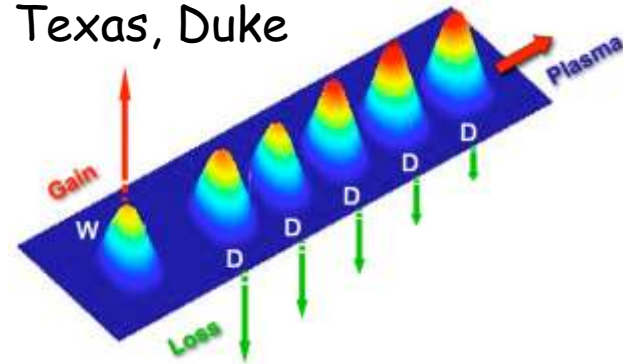
UCLA, USC, U. of Texas, Duke



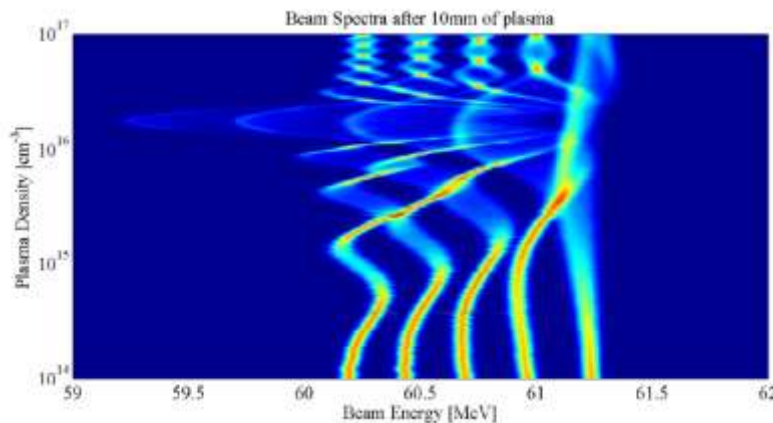
Simplified schematic of the mask principle. Only the dogleg section of the beam line is depicted (not to scale), and three quadrupole magnets are omitted. The side graphs represent the beam energy correlation with the beam front labelled by "F" and the back by "B."

Multi-bunch Plasma Wake Field Experiment

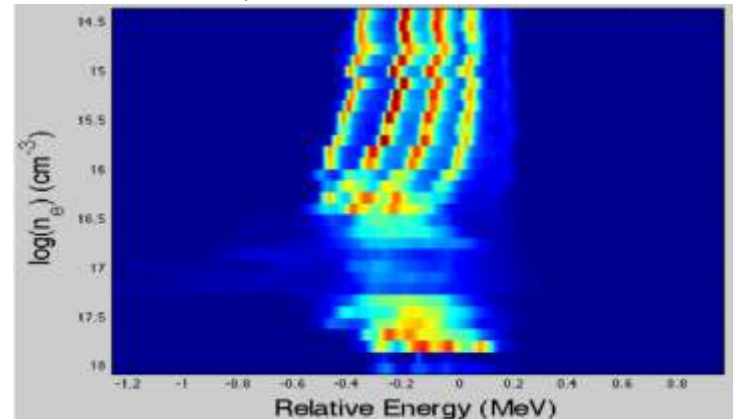
UCLA, USC, U. of Texas, Duke



Measured train of drive bunches excites high amplitude wake field



Complex interaction was studied in simulations

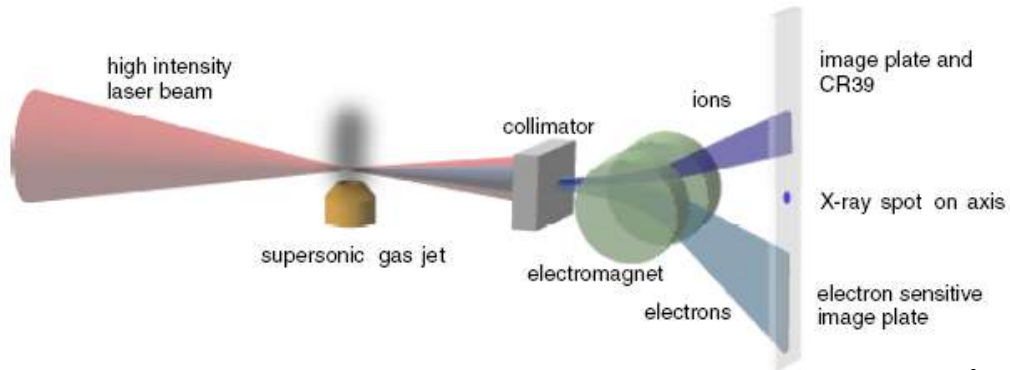


Characteristics of resonant interaction observed in first results

IEEE NPSS Particle Accelerator Science and Technology
Doctoral Student Award in 2009

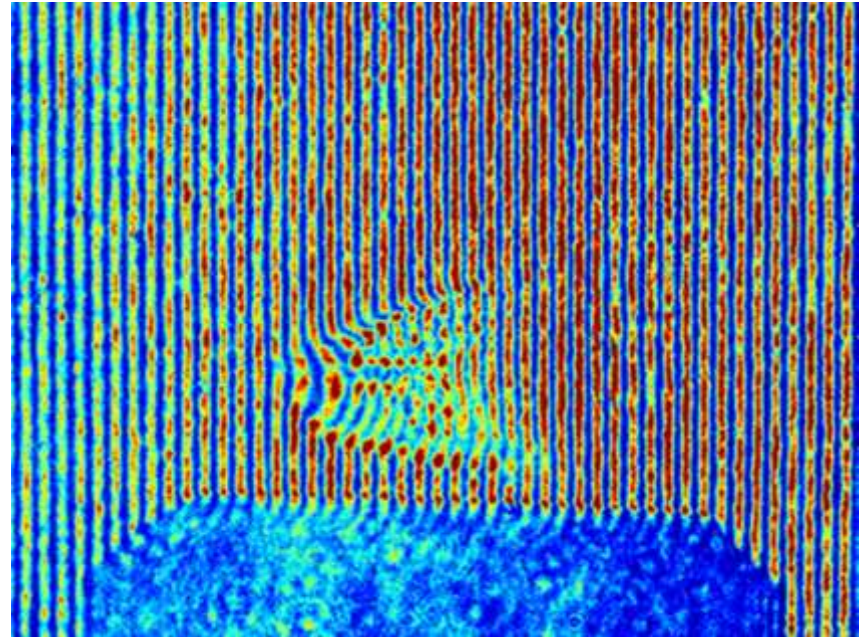
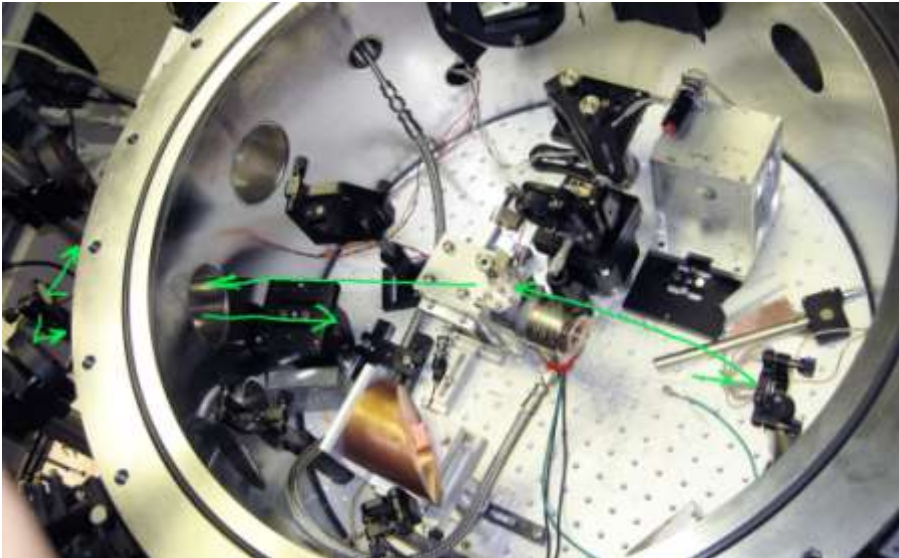
Interferometer probing of CO_2 laser plasma with YAG's 2nd harmonic

SUNY SB, U. Glasgow, Imperial College, Oxford



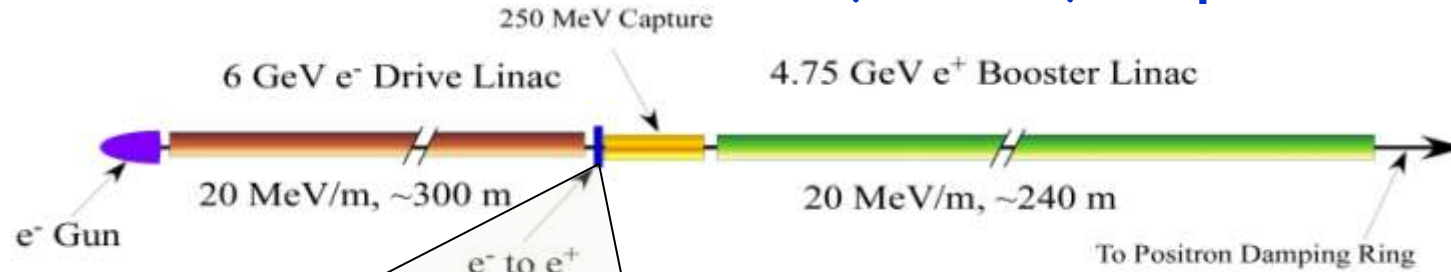
ATF CO_2 laser offers unique capability to probe ion generation from interaction of intense laser in overcritical density plasma

Interferogram of interaction with 10ps frame

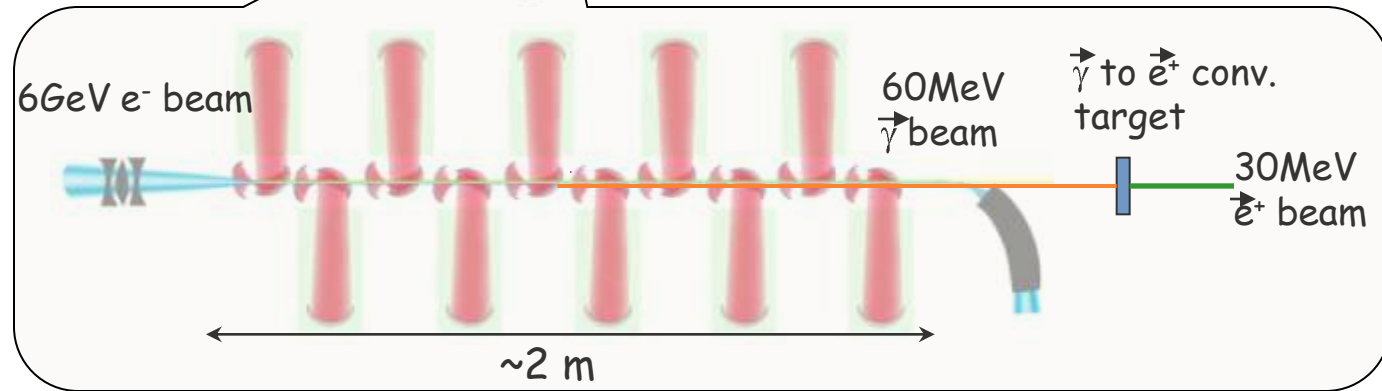


Polarized Positrons Source for ILC, CLIC, Super B

Conventional Non-Polarized Positrons:

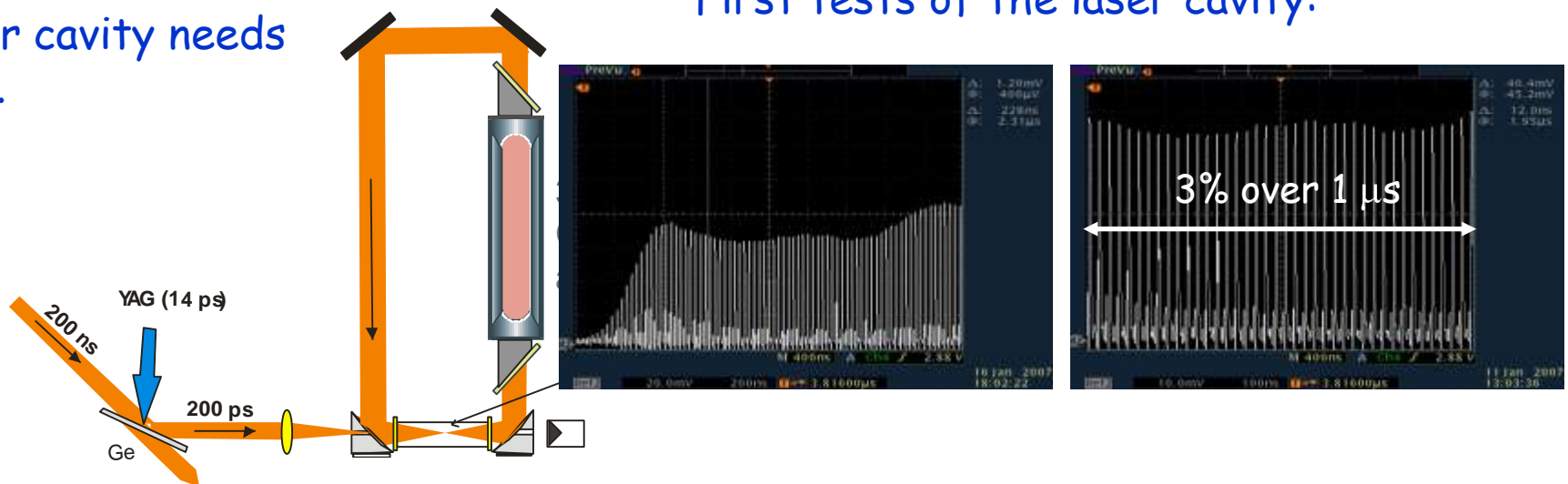


Polarized γ -ray beam is generated in the Compton back scattering inside optical cavity of CO2 laser beam and 6 GeV e^- beam produced by linac.



First tests of the laser cavity:

Laser cavity needs R&D.



In-house Gas Laser Simulation tool

Input: 5 ps, 10 μ J

Active medium: 30 cm

Gas:

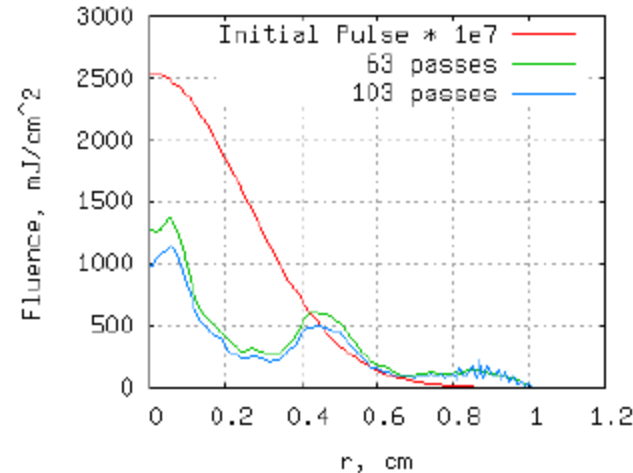
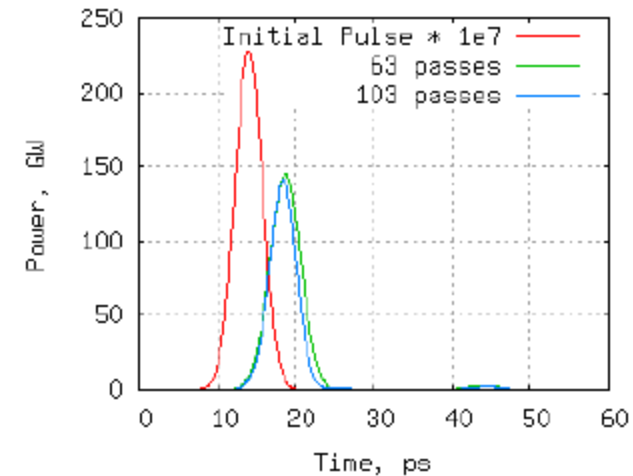
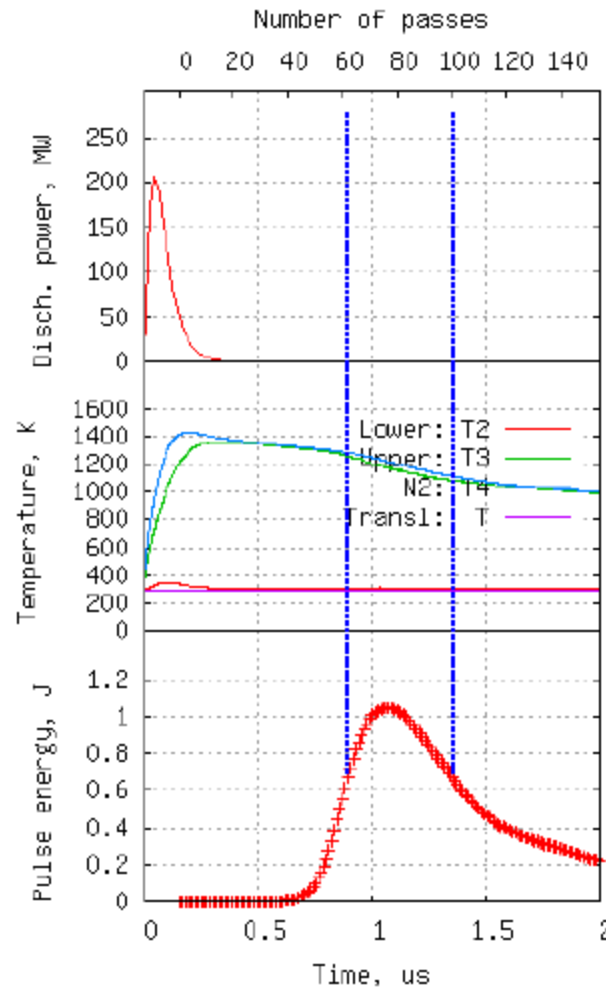
0.6:0.6:8.8 atm
(CO₂:N₂:He)

CO₂ isotopes:

0.15:0.3:0.15 atm
(CO₂¹⁶:CO¹⁶O¹⁸:CO₂¹⁸)

Injection: 1% reflector

Optical losses: 5% / pass



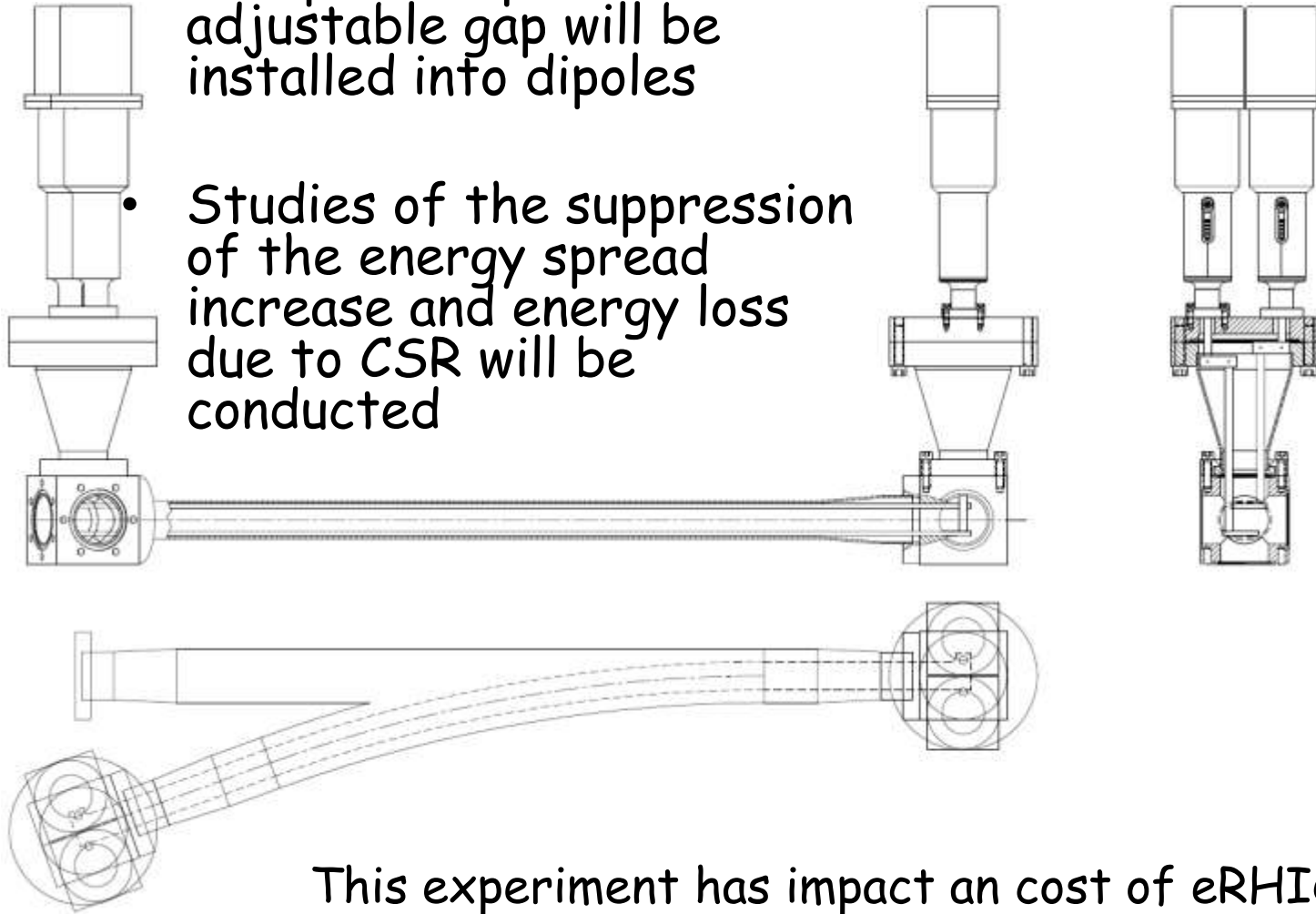
Recent fire at ATF

- Fire started due to failure of the high voltage capacitor in the pulse forming network of the Linac modulator.
- The modulator was completely destroyed (fire was contained to modulator cabinet)
- Replacement modulator was built ~6 month before the fire (cost of parts ~\$100k)
- Interlock systems disabled power to minimize chance of fire and made it safe for fire fighters.
- Operator on duty followed instructions prioritizing personal safety.
- Factors affecting the outcome were:
 - No high voltage trained person in the building at the time of the capacitor failure. (Both of the planned hires)
 - PCB based capacitors were replaced ~12 years ago with less reliable plastic casing capacitors filled with mineral oil
 - Replacement capacitors were ordered 2 days before the fire (at <25% of the specified life time).
- Lasers were not affected and after recertification of interlocks restarted operations within days
- Design of the protection system is improved, more robust model of the capacitors is installed.
- Investigation is ongoing

Coherent SR shielding test

USC, CAD BNL

- Two parallel plates with adjustable gap will be installed into dipoles
- Studies of the suppression of the energy spread increase and energy loss due to CSR will be conducted

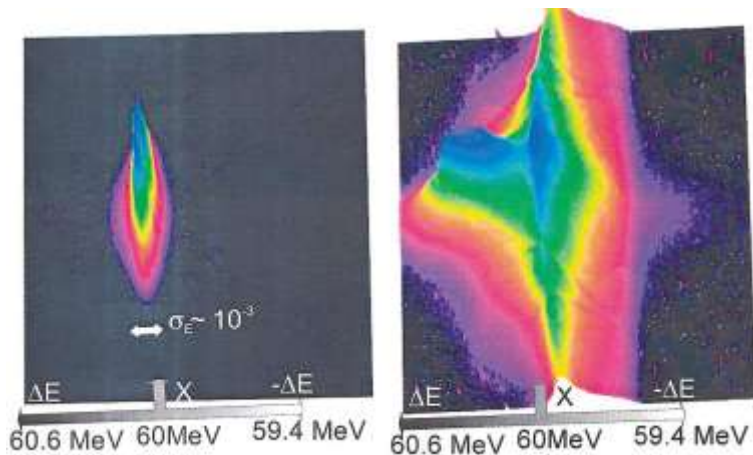


This experiment has impact on cost of eRHIC at ~25% level

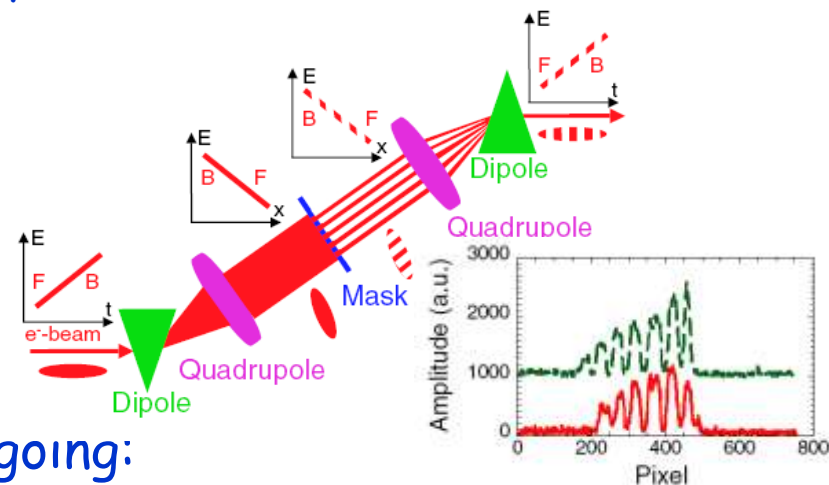
Plasma wake fields

UCLA, USC, U. of Texas, Duke

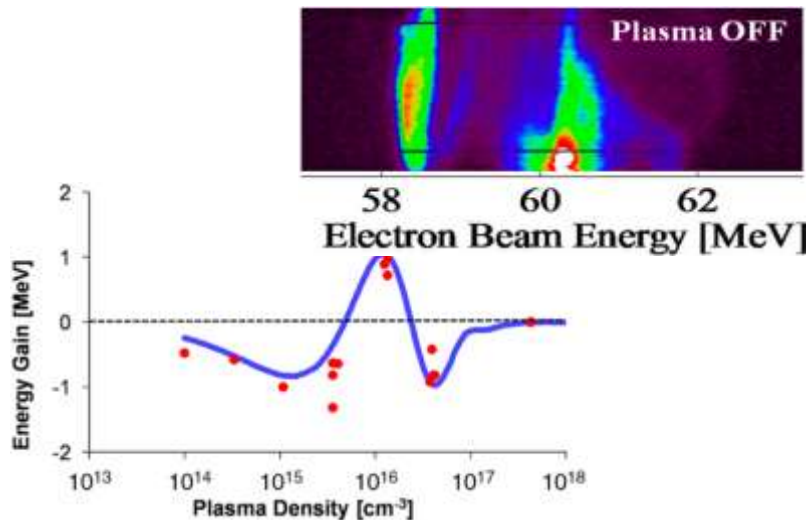
Phys. Rev. Lett. 91, 014802 (2003)



Phys. Rev. Lett. 101, 054801 (2008)

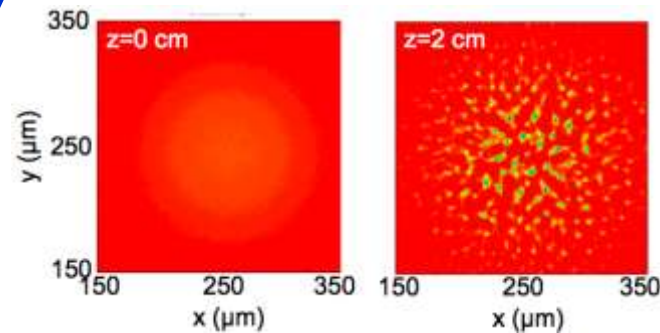


Phys. Rev. Lett. 100, 074802 (2008)

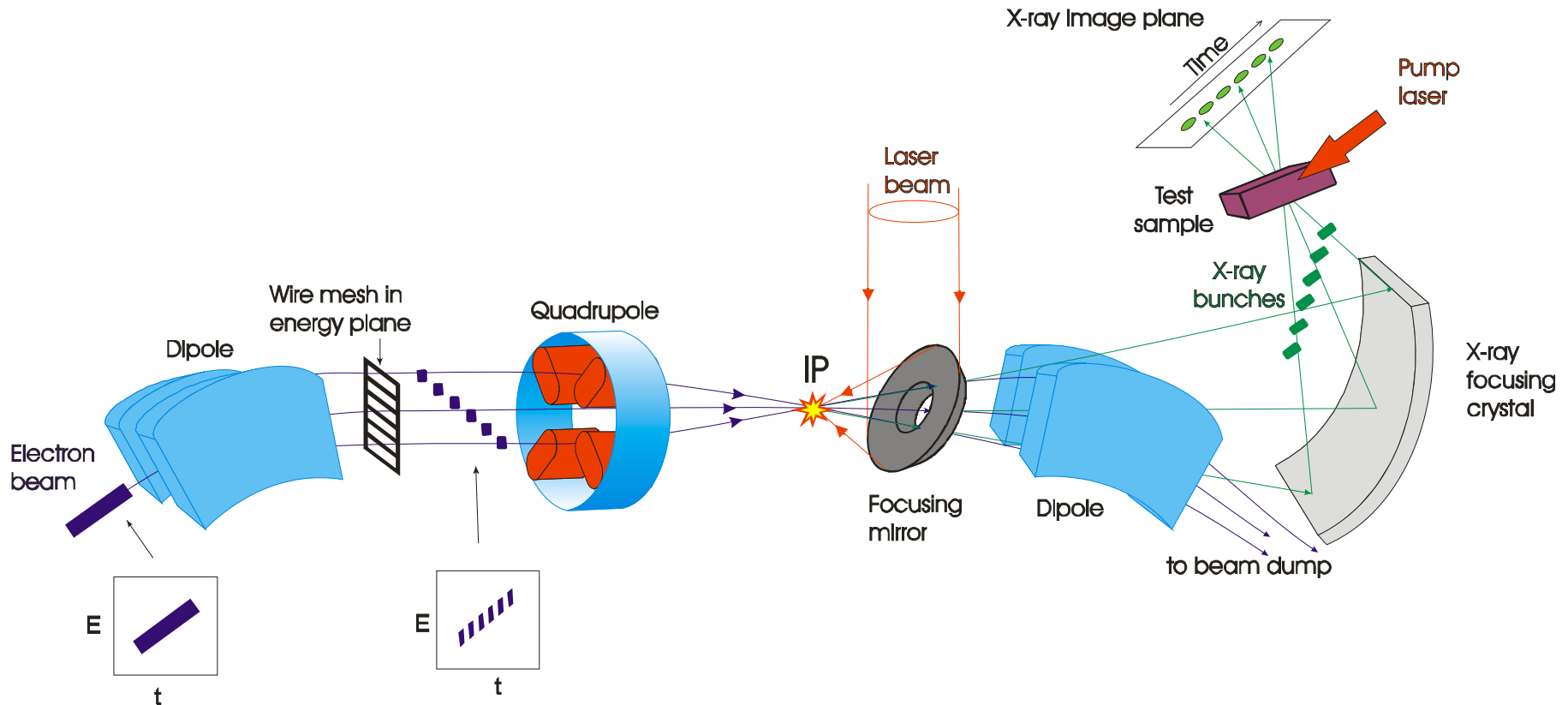


Ongoing:

- Resonant excitation of plasma wake fields using trains of electron bunches
- The current filamentation instability, akin to the Weibel instability

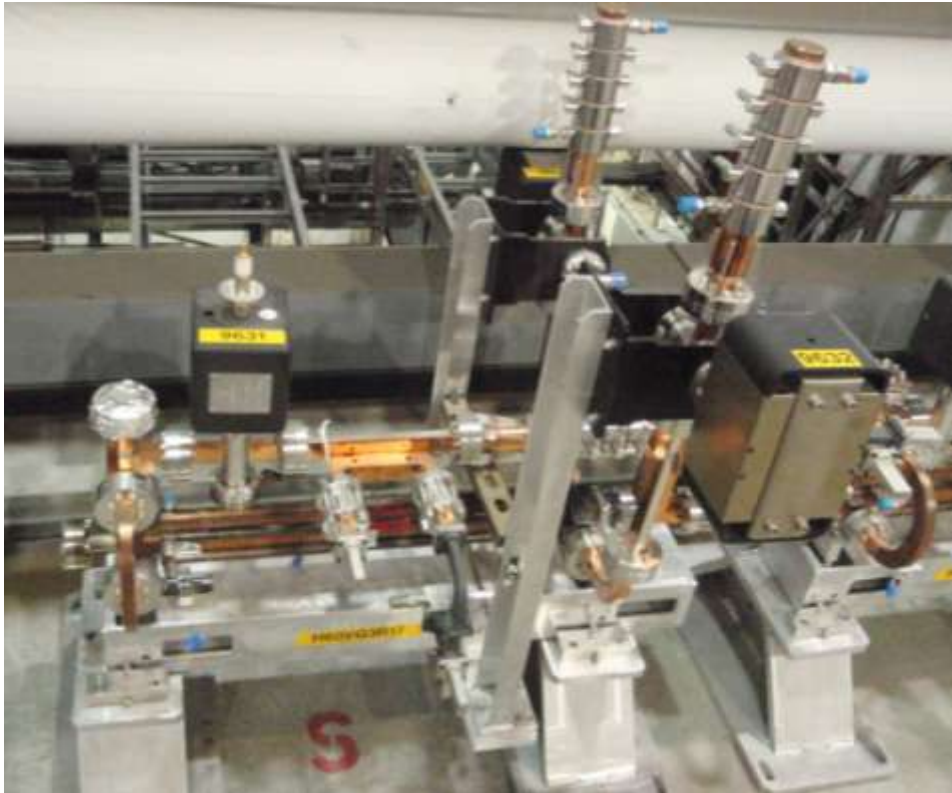


X ray movie camera



10^7 X-rays per beamlet are expected with 1% energy spread with 0.3 mrad divergence, $35\mu\text{m}$ source size and 100fs RMS duration. This correspond to peak brightness of 10^{23} ph/sec/mm²/mrad²/0.1%

X band klystron and section



Agreement for SLAC to supply klystron and accelerator section is finalized and funded.

Extraordinary collaborative help from SLAC (ATF getting a better deal than LCLS) deserves recognition -- SLAC management and LK Len.

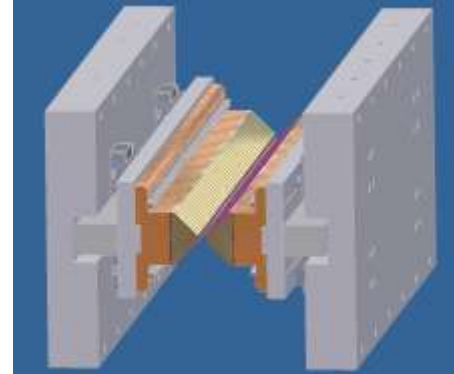
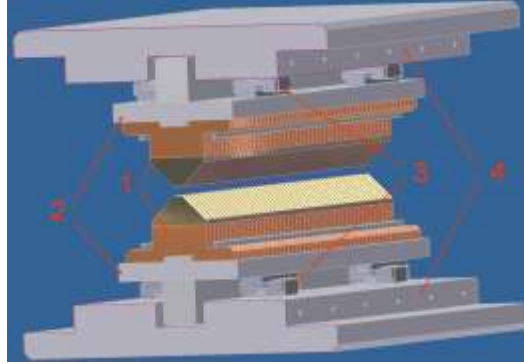
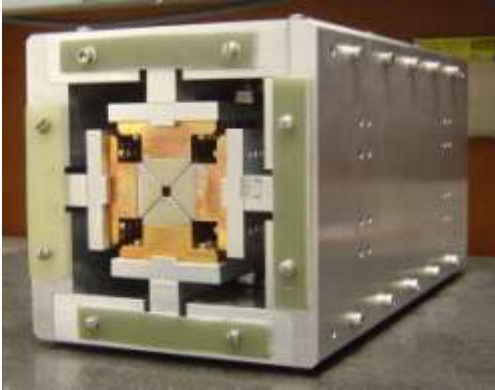
Many groups will benefit from X band technology available for user experiments with high brightness electron beam for the first time

Fully “staffed” and tested accelerator section is ready to be shipped to ATF.

Klystron will be build and delivered to ATF in about 12 months. Temporary loan klystron may be available sooner.

Very short tests

- Delta undulator from Cornell



- Second momentum cavities (Far-Tech)



- ...

ATF Organization Chart

